QUATRA

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Delft

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SEVENTH FRAMEWORK PROGRAMME

Software and Services for the Quality Management for Traffic Data (QUATRA)

Duration: 01/10/2011 – 30/09/2013 (24 months)

Budget: EUR 290.000

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presentation content

Content of the presentation

1. main project objectives (reminder)
2. progress report on research method
3. results of the literature review
4. works carried out (model and software development, workshops)
5. next steps

main objectives

Development of two tools for quality management

1. procedures and software tools will be developed to measure and estimate online the quality of incoming traffic data on **freeways** (for control centres)

2. furthermore a comparable service – offline – will be developed for **urban traffic** data (for cities and transport authorities)

progress report

The research method includes the following steps

- state-of-the art analysis 
- development of the strategy for data evaluation 
- development of algorithms and logic enquiries 
- tests with historical data

ongoing

- software development (applications, architecture)
- field tests

not yet started

- analysis of test results

results literature review

Results literature review

- objective: input of existing data quality evaluation for QUATRA
- technical approaches (check of specific data features)
- traffic engineering approaches (traffic flow fundamentals)
- guidelines and standard procedures (specifications)
- standardised systems and tools (developed/used at present)

- several interesting approaches identified
- integration of tests and methods depends on available data (levels)
- details included in development of indicators and criteria

works carried out

Works carried out

- development of the strategy for data evaluation
- definition of indicators and criteria
- finalisation of test sections and data sources (freeways)
- workshops with road authorities
- development of statistical and logic procedures
- development of the software platform (until 06/2013)
- selection of use cases for the freeway tool

Strategy for data evaluation

- combination of indicators and statistical model (Local/Global/Plausibility indicators)
- identification of "incidents"
- substitution of erroneous data based on historic traffic data

indicators and criteria

Selection of indicators and criteria

- two stage process
- first stage: project partners evaluated results of literature review separately
- second stage: interpretations and findings of both partners were shared and discussed
- definition of joined approach for definition of quality checks and model development

indicators and criteria

Example

Description, sources and suitability

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
1.	comparison of volumes and volume/occupancy ratio based on a 20-second intervals	Nihan Wang (1995)	volumes vs. detector utilisation - example: low traffic volumes should be represented in a low detector utilisation rate	1	0	1			
2.	vehicles change lanes physically at the location of the detection (splashover)	Coifman Lee (2011)	detectors on adjacent traffic lanes detect the same vehicle in case of lane change - could be filtered out (IF speed, time, vehicle is same)	2	1	1			
3.	same vehicles are detected twice at the same site (e.g. heavy vehicles with trailers)		testing of time gap at high speed detection, logical enquiry included in item M10	1	0	1			
4.	average vehicle lengths calculated and vehicle distributions estimated and compared with historical data	Turochy Smith (2000)	percentage of vehicle categories on total traffic ok or wrong (differences during time/day/location)	1	1	1	1	0	0
5.	on-times were assessed (ratio of vehicle lengths over speed), vehicle distributions were logically compared with similar vehicle distributions and the average ontime for a time interval e respectively to identify faulty data.	Coifman Lee (2006) Chen May (1987)							
6.	storage rates for time intervals	Nihan (1997)	can data be obtained about storage rates from single vehicle detections? Could be used as indicator for traffic queuing, logical enquiry included in item M19	1	1	1			
7.	minimum and maximum flow thresholds	Weijermars Berkum (2006)	included in items M12-M14						

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
8.	linear regression of the volumes of neighbouring sites	Chen et al. (2003)	for freeway section this criteria will be incorporated in the statistical model, for the urban road environment the density of traffic detection sites is highly relevant, high coverage is needed in order to get good results (partially included in item M20)	1	2	1	1	1	0
9.	measured flow values on neighbouring data collection sites								
10.	observation of unexpected high jumps of speed level and speed jumps			1	1	1	1	0	0
11.	If the speed is unexpected small, it is tested whether the speed is due to a traffic incident or measurement error occurred. The assumption was made that traffic incident in contrast to a measurement error is usually observed on all lanes.	Hoops (2002)	evaluation of average speeds in comparison to traffic volumes, indicator for traffic queuing	1	0	1	1	0	0
12.	Travel times from v and q		indicator for traffic queuing, can only be obtained in Austria through toll system data, for urban regionss maybe Decell or INRIX data is available	1	2	1	1	0	0
13.	Under the assumption that the travel time of a considered and specified driver group stays stable, the travel time, calculated from the distance between the detectors and the measured speed, has to be similar to the travel time found by correlation analysis.		indicator for traffic queuing, can only be obtained in Austria through toll system data, for urban regionss maybe Decell or INRIX data is available	1	2	1	1	2	
14.	conservation of flow: the test takes time series of different detection sites into account and calculates the quotient of the traffic volumes, estimates the distribution of the quotients and establishes the decision rules for data validation	nast consulting, TU Vienna (2008)	included in statistical model	1	2	1	1	1	0

test sections

Test sections on freeways

- Austria: sections on S 1, A 12
- Germany: sections on A 8, A 9, A 99
- Switzerland: no test sections

Test sections in urban areas

- Austria: Vienna
- Germany: Bremen

test sections

Workshops with authorities

- Toll system data could be used for evaluation purposes
- Check and substitution of speed data vital for traffic guidance
- User friendliness of the product very important
- Automated expert system could provide major benefit
- Labelling of erroneous data for statistics very important (also in case of road works, accidents…)
- Online focus very important
- Interface for road works database would be benefical

model development

Local indicators

- Missing data: number or ratio of missing data sets
- Failure messages : number or ratio of data sets with failure message "255" generated by the detector itself

Global indicators

- Conservation of flow: ratio of number of vehicles at neighbouring measurement cross sections under consideration of inflow and outflow at ramps (different vehicle categories)

model development

Plausibility indicators

- M1: $QKfz = 0 \Rightarrow (QLkw = 0 \text{ UND } QPkw = 0)$
- M2: $QKfz - QLkw = 0 \Rightarrow (QPkw = 0 \text{ UND } VPkw = 255)$
- M3: $QLkw = 0 \Rightarrow VLkw = 255$
- M4: $QPkw = 0 \Rightarrow VPkw = 255$
- M5: $QKfz \geq QLkw$
- M6: $QKfz - QLkw > 0 \Rightarrow 0 < VPkw$
- M7: $QKfz > 0 \Rightarrow 0 < VKfz$
- M8: $QLkw > 0 \Rightarrow 0 < VLkw$
- M9: $0 < t < T$
- M10: $QKfz = 0 \Rightarrow 0 < VGrenz,Kfz(t) = VGrenz,Kfz(t-T)$

model development

Plausibility indicators

- M11: VKfz > VGrenz $\Rightarrow$ B < Bgrenz
- M12: QKfz,min $\leq$ QKfz $\leq$ QKfz,max
- M13: QPkw,min $\leq$ QPkw $\leq$ QPkw,max
- M14: QLkw,min $\leq$ QLkw $\leq$ QLkw,max
- M15: VKfz,min $\leq$ VKfz $\leq$ VKfz,max
- M16: VLkw,min $\leq$ VLkw $\leq$ VLkw,max
- M17: VPkw,min $\leq$ VPkw $\leq$ VPkw,max
- M18: VGrenz,Kfz,min $\leq$ VGrenz,Kfz $\leq$ VGrenz,Kfz,max
- M19: Bmin $\leq$ B $\leq$ Bmax
- M20: VPkw,links > VPkw,rechts
- M21: VAusfahrt < VAusfahrt,grenz
- M22: QLkw,rechts > QLkw,links

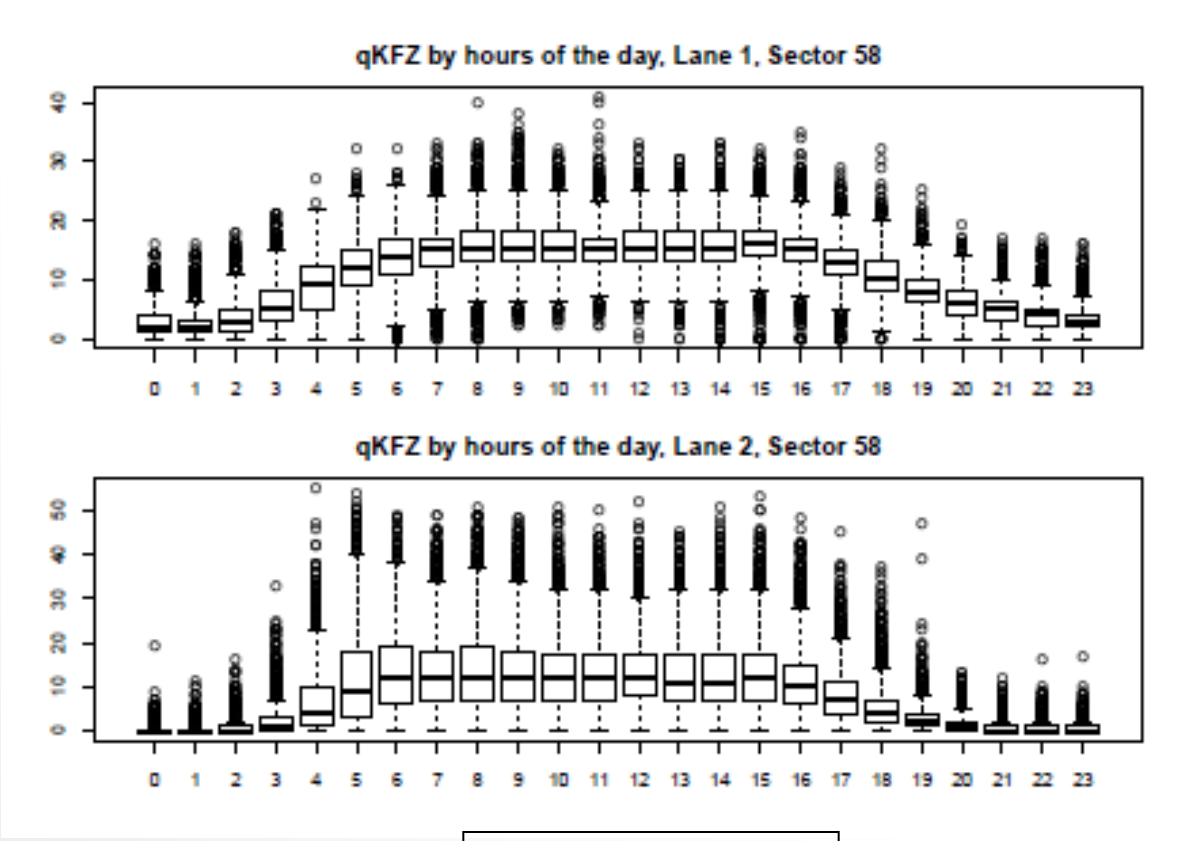
model development

Statistical model

- In order to decide whether detector measurements are likely to be faulty a general regression model is developed
- Statistical information of historical data is generated and used
- Prediction intervals are generated
- Value prediction based on linear combination of independent variables of the data set
- Optional: pre-imputation of missing values for both the dependent variable as well as independent variables

model development

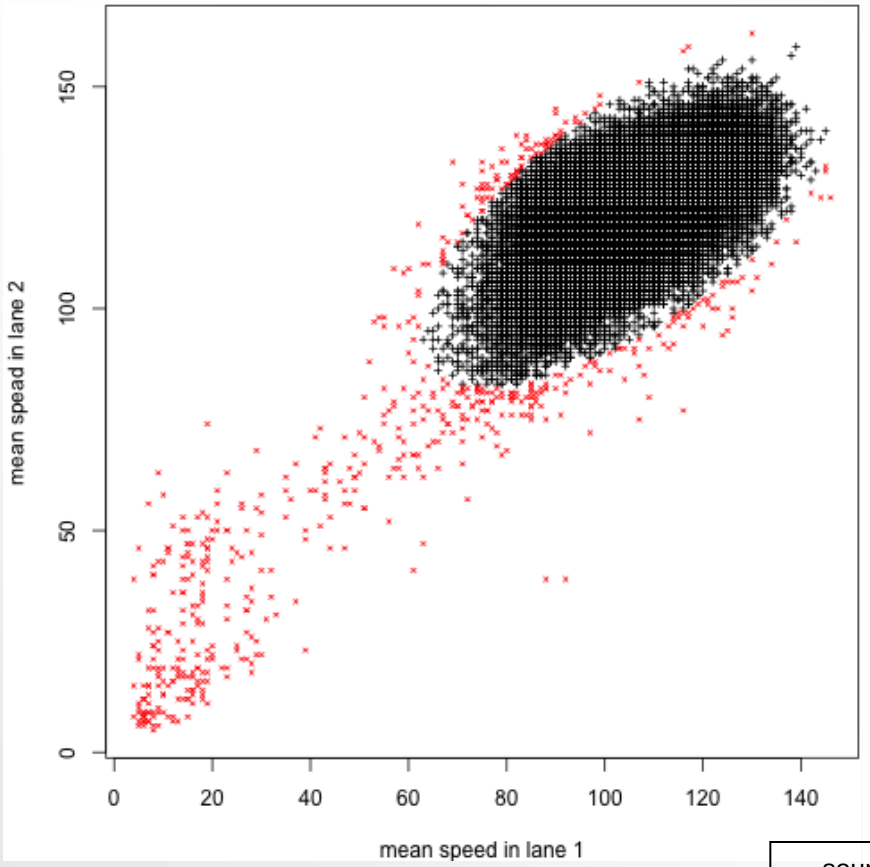
Statistical model – data analysis

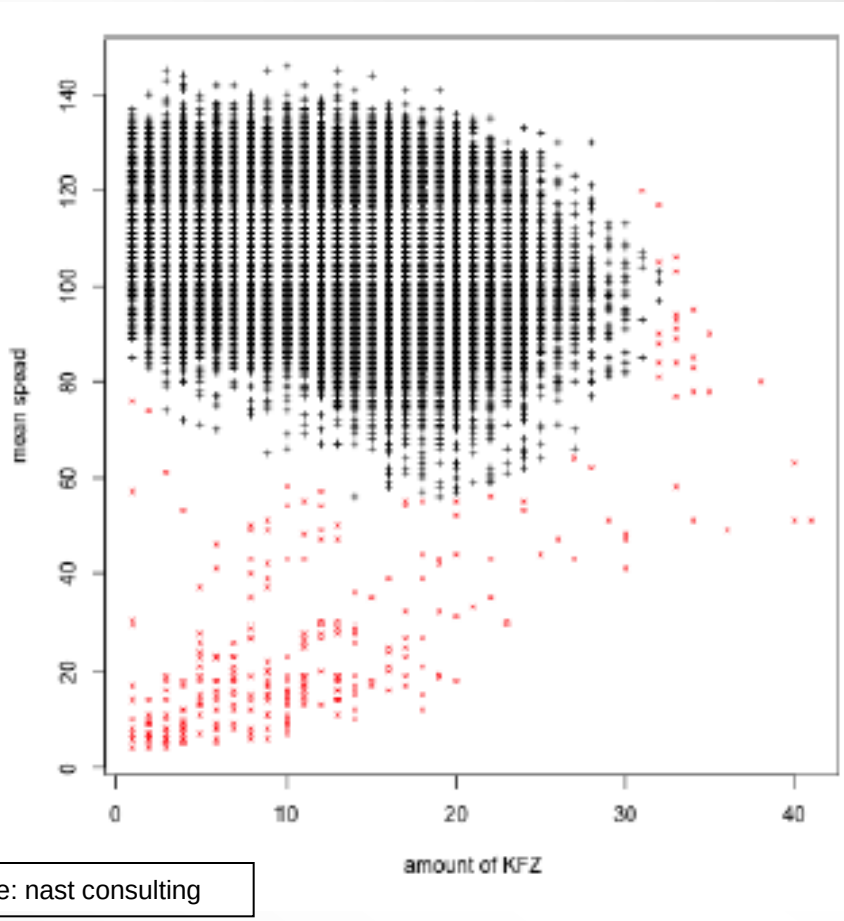


source: nast consulting

model development

Statistical model – data analysis





source: nast consulting

model development

Statistical model – example for input data

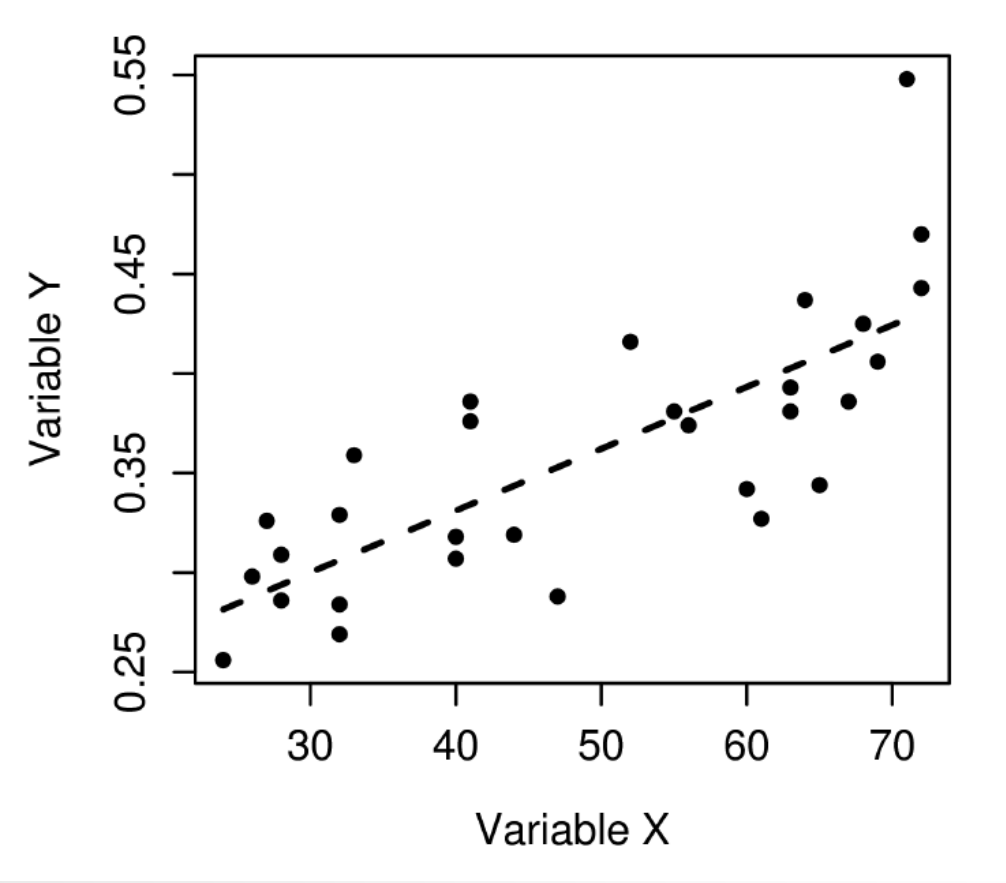
- *log*(*tNetto*): logarithm of variable net time gap (mean net gap between vehicles measured in 1/10 seconds)
- *classV A*: indicator of traffic volume defined as ranges
- *Weekday and hours*: factor variable specifying weekday (monday to sunday)
- *vPKW*: mean velocity of cars
- *lane:* indicator of lane
- *sector:* indicator of sector
- *Ist:* information provided by overhead displays (hazard, queuing, pollution, speed restrictions)

Example for enquiry code definition

$$qKFZ \sim log(tNetto) + classVA + weekday + vPKW + lane + sector + hour + Ist$$

model development

Statistical model



Source:
Hutcheson, G. D. (2011)
Ordinary Least-Squares Regression
In L. Moutinho and G. D. Hutcheson
The SAGE Dictionary of Quantitative
Management Research
Pages 224-228.

model development

Statistical model - identification of detector failure

- observed and collected values of number of vehicles for a given time interval at a specific lane on a given sector as well as the predicted number of vehicles for the exactly same time, lane and sector are available

- Identification of detector failure based on two assumptions
  1) the observed (measured) number of vehicles must lie within its corresponding prediction interval given by the results of the regression model
  2) the observed (measured) number of vehicles must lie within the range of the 2.5% and 97.5% percentile (normal range) of the distribution of number of vehicles for a given sector, lane, hour and hour of the day based on historical information

model development

Statistical model - additional features

- Additional check of robust measures of location and deviance: median values, robust measurement of dispersion for specific sector, lane and hour of the day

software development

Software Development - basic functionalities

- Daily calculation of quality indicators for all relevant detection sites
- Clear visualisation of quality indicators
- Plot of tables and diagrams
- Labelling of erroneous data in accordance to defined thresholds
- Functions of the user interface
- Selection of locations (freeway, chainage, lane, detector)
- Time section
- Visualisation of the road sections (no. of lanes, ramps, detector location)

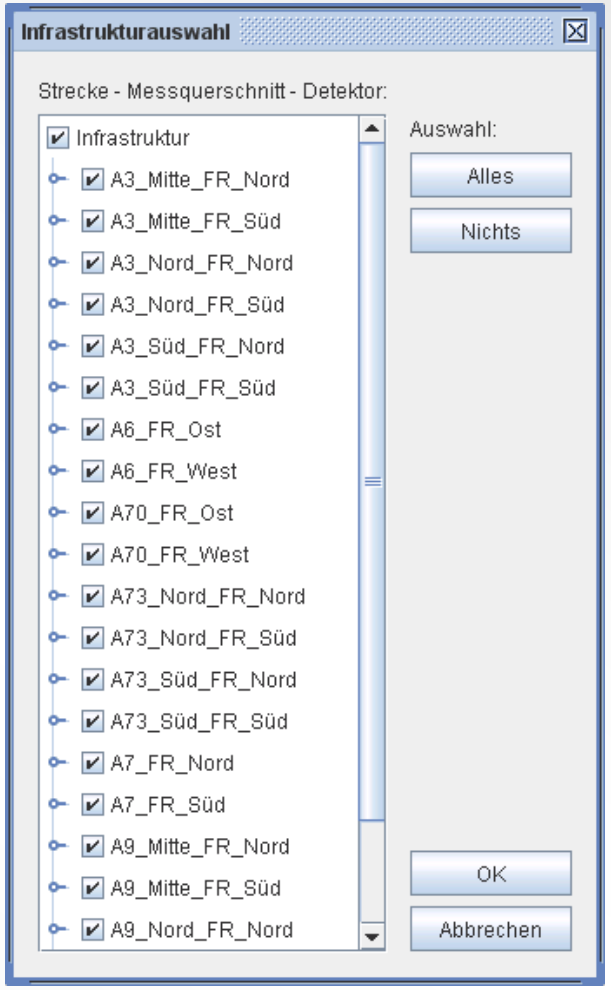
software development

Basic functionalities

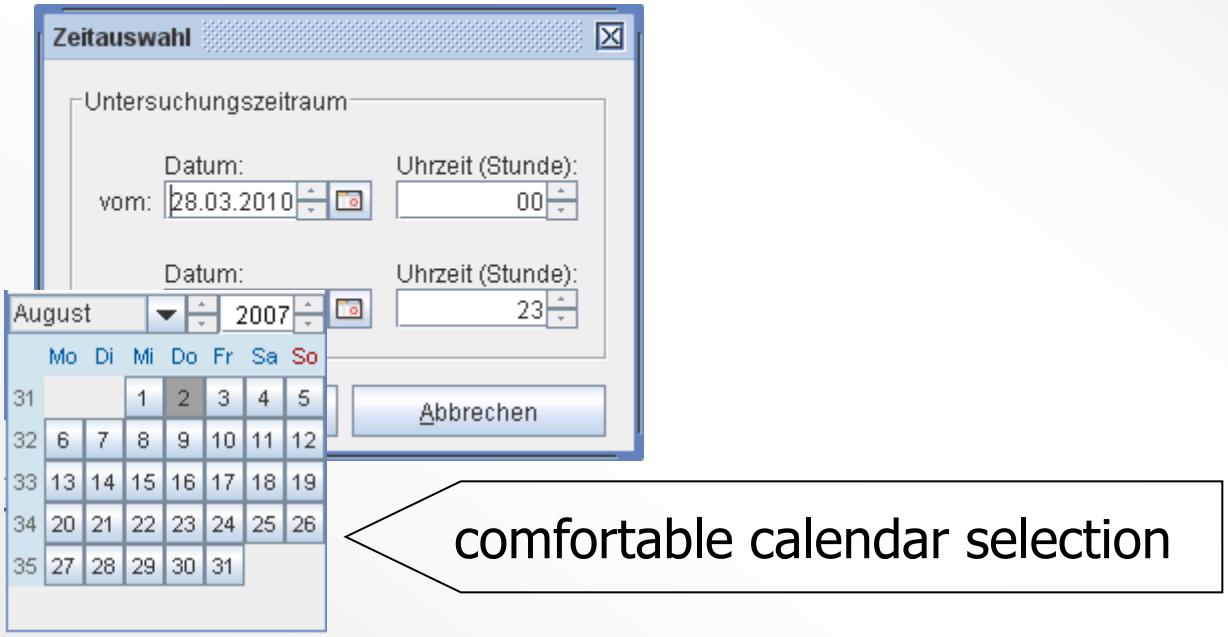
- Visualisation and export of indicators, tables und diagrams
- Dynamic window management (online tool)
- Selection of visualised indicators
- Display of thresholds
- Display of calculation parameters
- Diagram configuration
- Print, export, help, program settings

software development

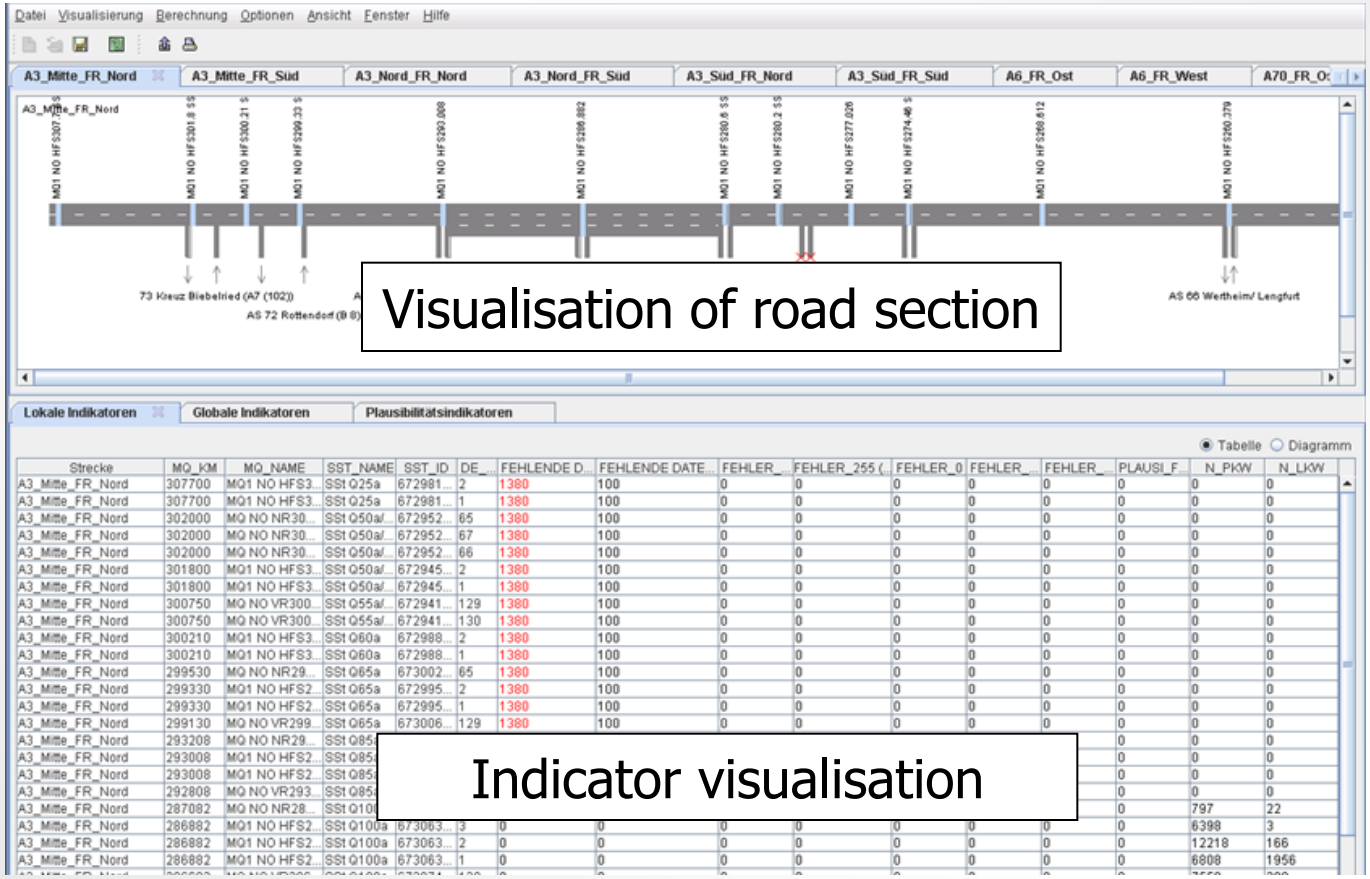
Location selection



Time selection



Indicators


Datei Visualisierung Berechnung Optionen Ansicht Fenster Hilfe
A3_Mitte_FR_Nord
A3_Mitte_FR_Süd
A3_Nord_FR_Nord
A3_Nord_FR_Süd
A3_Süd_FR_Nord
A3_Süd_FR_Süd
A6_FR_Ost
A6_FR_West
A70_FR_Ost
73 Kreuz Biebelried (A7 (102))
AS 72 Rottendorf (B 8)
AS 66 Wertheim/ Lengfurt
Visualisation of road section
Lokale Indikatoren
Globale Indikatoren
Plausibilitätsindikatoren
Tabelle
Diagramm
Indicator visualisation

software development

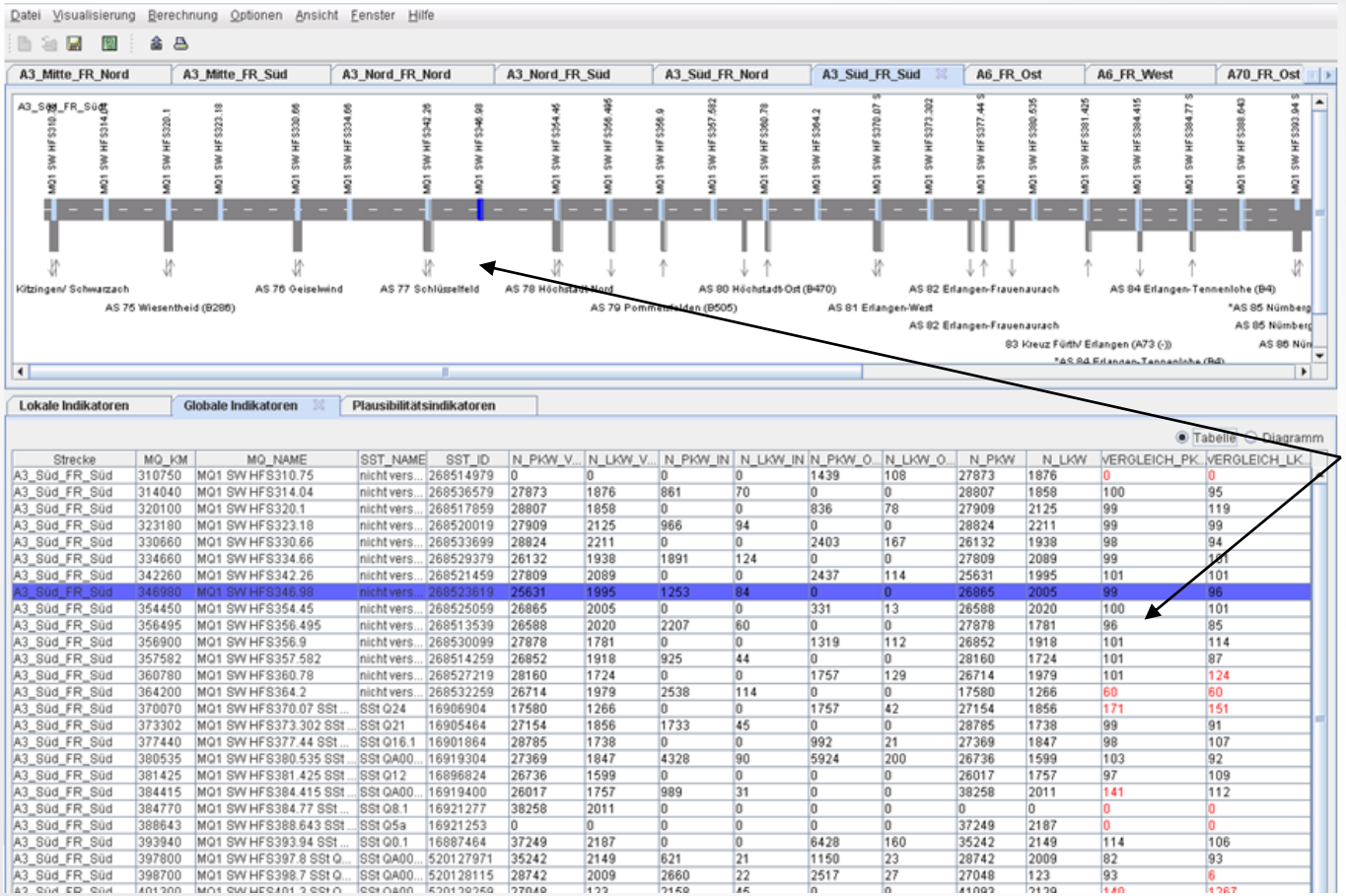
Indicators

Identification of threshold exceedings

thresholds

software development

Indicators



Strecke	MQ_KM	MQ_NAME	SST_NAME	SST_ID	N_PKW_V...	N_LKW_V...	N_PKW_IN	N_LKW_IN	N_PKW_O...	N_LKW_O...	N_PKW	N_LKW	VERGLEICH_PK...	VERGLEICH_LK...
A3_Süd_FR_Süd	310750	MQ1 SW HFS310.75	nicht vers...	268514979	0	0	0	0	1439	108	27873	1876	0	0
A3_Süd_FR_Süd	314040	MQ1 SW HFS314.04	nicht vers...	268536579	27873	1876	861	70	0	0	28807	1858	100	95
A3_Süd_FR_Süd	320100	MQ1 SW HFS320.1	nicht vers...	268517859	28807	1858	0	0	836	78	27909	2125	99	119
A3_Süd_FR_Süd	323180	MQ1 SW HFS323.18	nicht vers...	268520019	27909	2125	966	94	0	0	28824	2211	99	99
A3_Süd_FR_Süd	330660	MQ1 SW HFS330.66	nicht vers...	268533699	28824	2211	0	0	2403	167	26132	1938	98	94
A3_Süd_FR_Süd	334660	MQ1 SW HFS334.66	nicht vers...	268529379	26132	1938	1891	124	0	0	27809	2089	99	151
A3_Süd_FR_Süd	342260	MQ1 SW HFS342.26	nicht vers...	268521459	27809	2089	0	0	2437	114	25631	1995	101	101
A3_Süd_FR_Süd	346980	MQ1 SW HFS346.98	nicht vers...	268523619	25631	1995	1253	84	0	0	26865	2005	99	96
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A3_Süd_FR_Süd	356495	MQ1 SW HFS356.495	nicht vers...	268513539	26588	2020	2207	60	0	0	27878	1781	96	85
A3_Süd_FR_Süd	356900	MQ1 SW HFS356.9	nicht vers...	268530099	27878	1781	0	0	1319	112	26852	1918	101	114
A3_Süd_FR_Süd	357582	MQ1 SW HFS357.582	nicht vers...	268514259	26852	1918	925	44	0	0	28160	1724	101	87
A3_Süd_FR_Süd	360780	MQ1 SW HFS360.78	nicht vers...	268527219	28160	1724	0	0	1757	129	26714	1979	101	124
A3_Süd_FR_Süd	364200	MQ1 SW HFS364.2	nicht vers...	268532259	26714	1979	2538	114	0	0	17580	1266	60	60
A3_Süd_FR_Süd	370070	MQ1 SW HFS370.07 SSt ...	SSt Q24	16906904	17580	1266	0	0	1757	42	27154	1856	171	151
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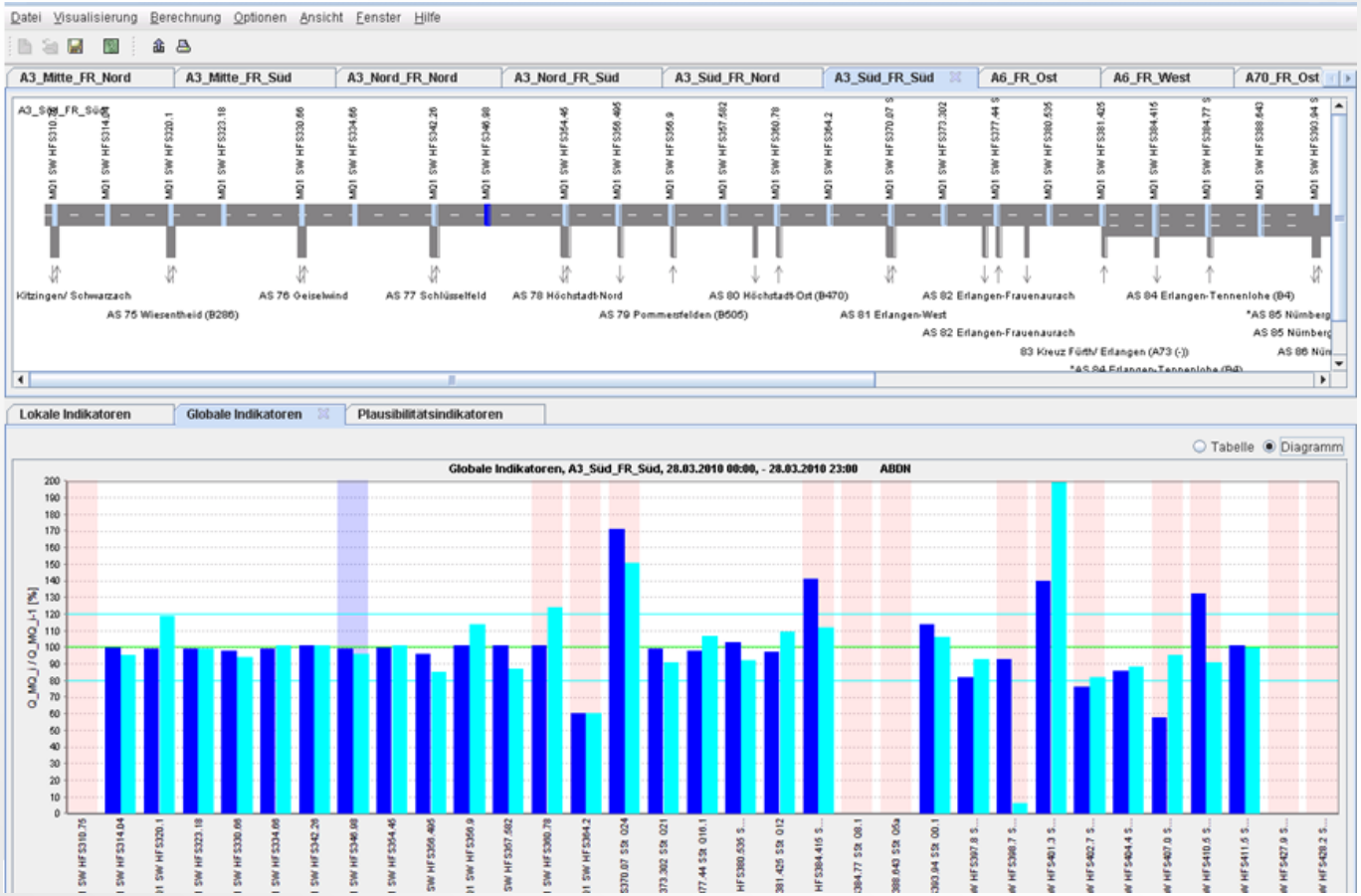
A3_Süd_FR_Süd	377440	MQ1 SW HFS377.44 SSt ...	SSt Q16.1	16901864	28785	1738	0	0	992	21	27369	1847	98	107
A3_Süd_FR_Süd	380535	MQ1 SW HFS380.535 SSt ...	SSt QA00...	16919304	27369	1847	4328	90	5924	200	26736	1599	103	92
A3_Süd_FR_Süd	381425	MQ1 SW HFS381.425 SSt ...	SSt Q12	16896824	26736	1599	0	0	0	0	26017	1757	97	109
A3_Süd_FR_Süd	384415	MQ1 SW HFS384.415 SSt ...	SSt QA00...	16919400	26017	1757	989	31	0	0	38258	2011	141	112
A3_Süd_FR_Süd	384770	MQ1 SW HFS384.77 SSt ...	SSt Q8.1	16921277	38258	2011	0	0	0	0	0	0	0	0
A3_Süd_FR_Süd	388643	MQ1 SW HFS388.643 SSt ...	SSt Q5a	16921253	0	0	0	0	0	0	37249	2187	0	0
A3_Süd_FR_Süd	393940	MQ1 SW HFS393.94 SSt ...	SSt Q0.1	16887464	37249	2187	0	0	6428	160	35242	2149	114	106
A3_Süd_FR_Süd	397800	MQ1 SW HFS397.8 SSt Q...	SSt QA00...	520127971	35242	2149	621	21	1150	23	28742	2009	82	93
A3_Süd_FR_Süd	398700	MQ1 SW HFS398.7 SSt Q...	SSt QA00...	520128115	28742	2009	2660	22	2517	27	27048	123	93	6

link of information on graph and tables

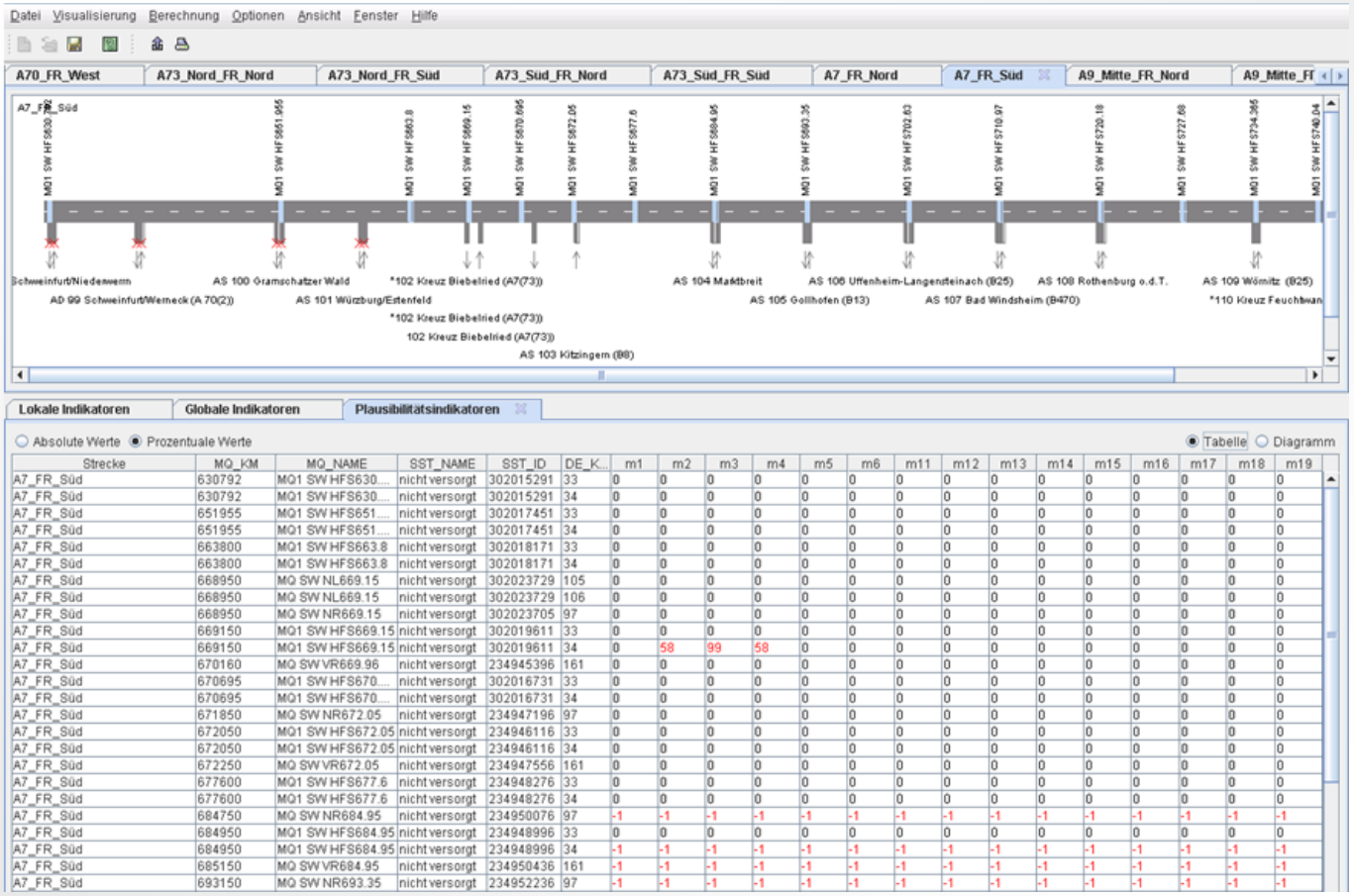
software development

Indicators



software development

Indicators



Strecke	MQ_KM	MQ_NAME	SST_NAME	SST_ID	DE_K...	m1	m2	m3	m4	m5	m6	m11	m12	m13	m14	m15	m16	m17	m18	m19
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A7_FR_Süd	663800	MQ1 SW HFS663.8	nicht versorgt	302018171	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	663800	MQ1 SW HFS663.8	nicht versorgt	302018171	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	668950	MQ SW NL669.15	nicht versorgt	302023729	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	668950	MQ SW NL669.15	nicht versorgt	302023729	106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	668950	MQ SW NR669.15	nicht versorgt	302023705	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	669150	MQ1 SW HFS669.15	nicht versorgt	302019611	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	669150	MQ1 SW HFS669.15	nicht versorgt	302019611	34	0	58	99	58	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	670160	MQ SW VR669.96	nicht versorgt	234945396	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	670695	MQ1 SW HFS670....	nicht versorgt	302016731	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	670695	MQ1 SW HFS670....	nicht versorgt	302016731	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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A7_FR_Süd	672050	MQ1 SW HFS672.05	nicht versorgt	234946116	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	672050	MQ1 SW HFS672.05	nicht versorgt	234946116	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	672250	MQ SW VR672.05	nicht versorgt	234947556	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	677600	MQ1 SW HFS677.6	nicht versorgt	234948276	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	677600	MQ1 SW HFS677.6	nicht versorgt	234948276	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	684750	MQ SW NR684.95	nicht versorgt	234950076	97	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
A7_FR_Süd	684950	MQ1 SW HFS684.95	nicht versorgt	234948996	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7_FR_Süd	684950	MQ1 SW HFS684.95	nicht versorgt	234948996	34	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
A7_FR_Süd	685150	MQ SW VR684.95	nicht versorgt	234950436	161	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
A7_FR_Süd	693150	MQ SW NR693.35	nicht versorgt	234952236	97	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

next steps

Next steps

- Further testing of algorithms and indicators
- Further software development
- Intensive networking with Urban Road Authorities
- Comparison of error detection of QUATRA and existing systems

expected results

Expected results

QUATRA should be able to be used by various telematic operators to offer user friendly data check services with the required quality.

- quality management tools for the assessment of traffic data on freeways and in urban environments
- software which is able to import and use different kinds of data streams and formats
- the software will inform operators about the quality standard by e.g. issuing automated reports

Thank you for your attention

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SEVENTH FRAMEWORK PROGRAMME

Appendix

model development

Statistical model

	possible suspicious	non-suspicious
Sept.	0.024	0.976
Oct.	0.030	0.970
Nov.	0.019	0.981
Dec.	0.021	0.979

Table 9: Share of measurements classicied as suspicious and non-suspicious according to strategy based on prediction intervals and historical quantiles

	possible suspicious	non-suspicious
Sep.	0.011	0.989
Oct.	0.011	0.989
Nov.	0.011	0.989
Dec.	0.011	0.989

Table 10: Share of measurements classicied as suspicious and non-suspicious according to strategy based on standardized residuals and historical quantiles

	possible suspicious	non-suspicious
Sept.	0.06	0.94
Oct.	0.05	0.95
Nov.	0.05	0.95
Dec.	0.06	0.94

Table 11: Detection of possible wrong measurements using robust techniques

project structure plan

WP 1 – Project Management	WP 2 – state-of-the-art analysis	WP 3 – Model Development	WP 4 – Software Development	WP 5 – field trial	WP 6 – Evaluation
1.1 Kick Off Meeting Steering Committee	2.1 literature review of data quality for detectors on freeways	3.1 define general indicators and criteria	4.1 define a software system and service	5.1 first test	6.1 evaluation and business concept
1.2 project structure plan with project budget and timetables	2.2 literature review of data quality for detectors in urban environment	3.2 define indicators specific for freeways	4.2 development online-freeway tool	5.2 adaption and analysis	
1.3 Meetings with Road Authorities		3.3 define indicators specific for urban networks	4.2 development urban - offline tool	5.3 second test	
1.4. coordination meetings		3.4 development freeway model			
1.5. finalisation		3.5. development urban service model			

finished
ongoing
not started

indicators and criteria

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
15.	value occupancy and flow minimum and maximum thresholds	Freudenberger (2001)	included in items M12-14 and M19	1	1	1			
16.	The speed was calculated from q and o due to the correlation of the fundamental diagram. If the speed exceeded the speed limit at the specific detector, the dataset was marked as implausible		logical combination of parameters of fundemtal diagram (can only be evaluated of individual vehicle speeds are available for analysis)	1	1	1	1	0	0
17.	The data was checked regarding recurrence		check, if single vehicles can be detected (data issue)	1	1	1	1	1	1
18.	regression curve second order was placed in a fundamental diagram. Measurement data with a significant high distance to the regression curve were marked as suspect		included in statistical model	1	1	1	1	0	0
19.	The coefficient of determination described how good the scatter plot was represented by the regression curve. If the coefficient of determination was small, there was only a small correlation between o and q und the detector was treated is possibly defect.			1	1	1	1	1	0
20.	conservation of flow: comparison of number of vehicles at neughbouring traffic sites - under consideration of on- and off ramps	nast consulting TRANSVER	included in statistical model	1	2	1	1	1	1
21.	conservation of flow: comparison of number of heavy vehicles at neughbouring traffic sites - under consideration of on- and off ramps		included in statistical model	1	0	1	1	1	0
22.	M1: QKfz = 0 Þ (QLkw = 0 UND QPkw = 0)		total traffic must be the sum of individual vehicle categories. If no vehicles total were counted during time period no car or HV can be registered	1	1	1	1	0	0

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
23.	M2: QKfz – QLkw = 0 ⇒ (QPkw = 0 UND VPkw = 255)	nast consulting TRANSVER	example: if total traffic = total vehicles category 1 there can't be any amount of vehicles for category 2... - furthermore speed of category 2... must be 0	1	1	1	1	0	0
24.	M3: QLkw = 0 ⇒ VLkw = 255		if no HV has been counted average speed must be 0 or code 255	1	1	1	1	0	0
25.	M4: QPkw = 0 ⇒ VPkw = 255		if no car has been counted average speed must be 0 or code 255	1	1	1	1	0	0
26.	M5: QKfz ≥ QLkw		total traffic must be sum of all vehicles categories	1	1	1	1	0	0
27.	M6: QKfz – QLkw > 0 ⇒ 0 < VPkw		if cars have been counted average car speed must increase	1	1	1	1	0	0
28.	M7: QKfz > 0 ⇒ 0 < VKfz		if vehicles have been counted average speed must be present	1	1	1	1	0	0
29.	M8: QLkw > 0 ⇒ 0 < VLkw		if vehicles have been counted average speed must be present	1	1	1	1	0	0
30.	M9: 0 < t < T		covers item 1 - detector utilization time must be higher 0 and shorter than time interval	1	2	1	1	0	0
31.	M10: QKfz = 0 ⇒ 0 < Vg,Kfz(t) = Vg,Kfz(t-T)		if no vehicle has been counted during time interval, averaged vehicle time must be higher 0 and same as previous time period	1	2	1	1	0	0
32.	M11: VKfz > VGrenz ⇒ B < Bgrenz		If average vehicle speed is high during a time interval the detector occupancy rate has to be below a certain treshold (fundamental diagram)	1	2	1	1	0	0
33.	M12: QKfz,min ≤ QKfz ≤ QKfz,max		traffic volumes during a certain time have to be within a certain range - otherwise there is a disturbance - refer to item 7	1	1	1	1	0	0

indicators and criteria

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
34.	M13: QPkw,min ≤ QPkw ≤ QPkw,max		car volumes during a certain time have to be within a certain range - otherwise there is a disturbance - refer to item 7	1	1	1	1	0	0
35.	M14: QLkw,min ≤ QLkw ≤ QLkw,max		HV volumes during a certain time have to be within a certain range - otherwise there is a disturbance - refer to item 7	1	1	1	1	0	0
36.	M15: VKfz,min ≤ VKfz ≤ VKfz,max		average vehicle speed during a certain time has to be within a certain range - otherwise there is a disturbance - refer to item 7	1	1	1	1	0	0

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
37.	M16: VLkw,min ≤ VLkw ≤ VLkw,max	nast consulting TRANSVER	average HV speed during a certain time has to be within a certain range - otherwise there is a disturbance - refer to item 7	1	1	1	1	0	0
38.	M17: VPkw,min ≤ VPkw ≤ VPkw,max		average car speed during a certain time has to be within a certain range - otherwise there is a disturbance - refer to item 7	1	1	1	1	0	0
39.	M18: Vg,Kfz,min ≤ Vg,Kfz ≤ Vg,Kfz,max		smoothed vehicle speed from during a certain time has to be within a certain range - otherwise there is a disturbance	1	2	1	1	0	0
40.	M19: Bmin ≤ B ≤ Bmax		average car speed during a certain time has to be within a certain range - otherwise there is a disturbance - refer to item 6	1	2	1	1	0	0
41.	M20: VPkw,links > VPkw,rechts		Germany: average car speed in right freeway lane should be below average car speed in left freeway lane (due to driver behaviour this assumption can not be used for Austrian motorways and urban areas)	1	2	1	1	0	0
42.	M21: VAusfahrt < VAusfahrt,grenz		average vehicle speed at on-/off ramps during a certain time has to be within a certain range - otherwise there is a disturbance	1	0	0	1	0	0
43.	M22: QLkw,rechts > QLkw,links		HV volume in left freeway lane should be below HV volume in left freeway lane (problem during overtaking manouvres)	2	2	1	1	0	0
44.	Indication of sources of errors based on previous events of the same type that were saved in the database	DAVINCI	should be included in a follow up project	0	0	0	-	-	-
45.	Peak-Hour-lane occupancy: erroneous data outside of operating hours		outside of operating hours the number of detected vehicles should be below a certrain threshold	1	0	1	1	0	0
46.	Acceptance monitor of speeds (checking whether the traffic control strategy, which was shown on the road, was accepted by the drivers)	BUSCH	not part of core focus of quatra, could be used for evaluation of compliance to dynamic signage	0	0	0	-	-	-

indicators and criteria

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
47.	For the current project the possible fault scenarios and sources of error of the individual ways of data collecting described in the reference note are of interest.	FGSV AK 3.5.20	wrong number of vehicles or no vehicle recorded, wrong classification of vehicles, wrong speed, repetition of interval data, included in logical enquiries M	1	1	1			
48.	repetition of interval data with same time stamp	-	indicator for data error	1	1	1	1	1	0
49.	comparison of volumes and average speeds	DVS Netz pilot nast consulting	according to results of research project high chance of queuing in case of high volumes and low average speeds	1	1	1	1	0	0
50.	comparison of volumes and average speeds	DVS Netz pilot nast consulting	in case of high traffic density average speed can't be high due to fundamental diagram	1	1	1	1	0	0
51.	Highway Agencies' requirements for assessment of data quality (target parameter, degree of accuracy)	MCH1529	potential benefit for software platform	1	0	1	1	1	1
52.	fault monitoring/reporting		potential benefit for software platform	1	1	1	-	-	-
53.	Plausibility check of short-term data, differentiation between inflowing and outflowing traffic	FGSV AK 3.5.20	covered in item 16	2	1	0	-	-	-
54.	data quality requirements regarding completeness, availability, veracity, precision, timeliness	QUANTIS	included in some of the M rules				-	-	-
55.	missing data (quantities)	nast consulting TRANSVER	potential benefit for software platform output	1	1	1	1	1	1
56.	missing data (percentage)		potential benefit for software platform output	1	1	1	1	1	1
57.	missing data code 255 (quantities)		potential benefit for software platform output	1	1	1	1	0	0
58.	missing data code 255 (percentage)		potential benefit for software platform output	1	1	1	1	0	0
59.	missing data code 0 (quantities)		potential benefit for software platform output	1	1	1	1	1	1
60.	missing data code 0 (percentage)		potential benefit for software platform output	1	1	1	1	1	1
61.	flagged data sets (resulting out of quality checks - quantities)		potential benefit for software platform output	1	1	1	1	1	1
62.	flagged data sets (resulting out of quality checks - percentage)		potential benefit for software platform output	1	1	1	1	1	1

item	criteria and indicators	source	description	0 - not suitable, 1 - suitable, 2 - partially suitable			stationary and local data (q,v,k,s, occ...)		global data
				freeway	urban	temp hard shoulder	TLS data sources (loops/radar/TEU)	toll system data, bluetooth, ANPR, DECELL, INRIX	
63.	monitoring levels	TRAFFIC IQ	potential benefit for software platform	1	1	1			
64.	reference systems and data fusion		potential benefit for software platform	1	1	0	1	1	1
65.	examined under a full range of traffic (Free Flowing, Heavy traffic with flow breakdowns, Stop-start conditions, Varied classifications of vehicles) and environmental conditions likely to be experienced on the network	MCH1529	included in some of the M rules	1	1	1	1	1	1
66.	comparison of data detection values and interpolated data (Quatra output)	workshop ASFINAG 01/2012	potential benefit for software platform output	1	1	1	1	1	1